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# तरलों के नमूने-प्रहस्तान तंत्रो की कार्यकारिका अभिव्यक्ति

*Indian Standard*

# EXPRESSION OF PERFORMANCE OF SAMPLE HANDLING SYSTEMS FOR FLUIDS

UDC 681’2’08 : 681·121

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 7

Electronic Measuring Equipment Sectional Committee, LTD 21

## FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on 19 March 1990, on the recommendations of the Electronic Measuring Equipment Sectional Committee and -approval of the Electronics and Telecommunication Division Council.

The object of this standard is to specify tests performed to determine the functional performance of a sample handling system and also to specify the information required by the user and the manufacturer. The information to the manufacturer -may be provided by the manufacturer of process analyser or by the manufacturer of sample handling system components.

While preparing this standard, assistance has, been derived from the document 66D ( Central Office) 12 'Expression of performance of sample handling systems for process analyzers', issued by the International Electrotechnical Commission ( IEC ).

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values ( ***revised*** )'.

# *Indian Standard*

# EXPRESSION OF PERFORMANCE OF SAMPLE HANDLING SYSTEMS FOR FLUIDS

## 1 SCOPE

**1.1** This standard applies to systems handling gaseous or liquid samples for process analyzers used for any ultimate purpose (process control, emission, ambient air measurements, etc). It does not apply to systems for handling solid samples.

1.2 It applies to complete sample handling systems as well as to sample handling system components. Power supplies and instrumentation for providing or controlling other utilities necessary for process analysers or sample handling system components are considered part of the system only in so far as they are a functional part of it.

1.3 It applies to facilities for maintaining the performance of the sample handling system.

1.4 It applies to facilities for maintaining the performance of the analyser if these facilities are part of the sample handling system and not of the analyser.

1.5 General aspects of gas analysers are not dealt with in this standard.

1.6 This standard does not deal with safety aspects concerning electric, explosive or toxic hazards.

1.7 Electric safety requirements are dealt with in IS 9858 : 1981. Safety requirements for electronic measuring equipment.

1.8 Indian Standard on general requirements for electrical apparatus for use in explosive atmosphere is under preparation.

1.9 The influence by environmental conditions is dealt with in IS 9000 series of standards.

1.10 Requirements for output signals are dealt with in IS 8493 : 1977 'Analogue dc voltage signals for industrial process measurement and control system', and IS 7722 : 1975 'Analogue pneumatic signals for process control systems'.

1.11 This standard is in accordance with the general principals set out in IS 9176 : 1979 'Methods for specifying the functional performance of the electronic measuring equipment'.

## 2 REFERENCES

**2.1** The following Indian Standards are necessary adjuncts to this standard.

| *IS No.* | Title |
|---|---|
| 196 : 1966 | Atmospheric test conditions for testing ( *revised)* |
| 1890 ( Parts 0 to 13) | Quantities, units and symbols |
| 7728 : 1984 | Analogue dc current signals for process control systems ( *first* revision ) |
| 10005 : 1985 | SI units and recommendations for the use of their multiples and of certain other units ( *first revision )* |

## 3 DEFINITIONS AND PROCEDURES FOR STATEMENTS

### 3.1 General Definitions

( **See** Annex A and Fig. 3 and 4 for a description of sample handling system )

3.1.1 ***Process Analyser***

An analytical instrument connected to a source fluid that automatically provides output signals giving information in relation to a quantity of one or more components present in a fluid mixture or in relation to physical or chemical properties of a fluid which depends on its composition.

NOTE — For on line or extractive process analysers a sample stream is extracted from the source fluid and transported to the analyser. With an in line or in-situ analyser the measurement is performed within the source fluid.

3.1.2 ***Sample Handling System***

A system which connects one or more process analysers with the source fluid, disposal points and utilities.

NOTE — A sample handling system may extract the required sample stream from one or more source fluids and condition it in order to meet all the input requirements of the process analyser so that an accurate measurement of the properties under investigation is possible. The system may also ensure the appropriate disposal of exhaust streams and the supply of utilities as necessary.

Instrumentation for ensuring the process analyser or of a sample handling system components or for facilitating maintenance work is considered part of the sample handling system if it is a functional part of it (see Annex A, Fig. 4 for an example ).

3.1.3 Sample *Extraction*

The function of those parts of a sample handling system which extract the required sample stream from the source fluid.

NOTE — The sample stream should be extracted in such a way that the information which is to be acquired is not biased.

3.1.3.1 *Source fluid*

The fluid ( gas or liquid ) from which the sample stream is extracted and of which the composition or properties are to be measured.

NOTES

1 The source fluid may flow through a process line or fill a volume. Ambient air can also be the source fluid.

2 The source fluid and the sample fluid in the sample line may consist of a combination of the following components ( *see* Fig. 1 ):

- Components to be measured,
- Irrelevant components,
- Obstructive components, and
- Interfering components.

3.1.3.2 *Components to be measured*

The components or group of component of which a quantity ( for example, concentration) is to be measured by the process analyser.

3.1.3.3 *Property to be measured*

The physical or chemical property which is to be measured by the analyser and which depends on the composition of the source fluid.

**3.1.3.4** *Irrelevant components*

The components which are not to be measured and which do not affect the performance of the analyset or of the sample handling system.

3.1.3.5 *Obstructive components*

The components which adversely affect the performance of the analyser or of sample handling system components. The effect may be:

- physical ( for example, by dirtying windows in optical analysers ); or
- chemical ( for example, by corrosion ); or
- by causing unacceptable errors ( for example, bubbles in a liquid sample stream for a photometer ).

Obstructive components can be solid, liquid or gaseous.

3.1.3.6 *Interfering components*

The components which give rise to unacceptable interference errors in the analyser.

3.1.3.7 *Sampling point*

The point where the sample stream is extracted from the source fluid.

NOTE — It may be necessary to have a combination of sampling points at the inlet of a sample handling system. The sample streams from different sampling points can be mixed or be measured separately.

**3.1.4** *Sample* Transport

The function of these parts of a sample handling system which transfer the sample fluid from the sampling point to the inlet of the process analyser .

**3.1.4.1** *Sample line*

The connection from the sampling point(s) to the analyser inlet in which a stream is allowed to flow.

NOTE — Filters, coolers, pumps, flowmeters, etc, may be part of the sample line ( see Annex A, Fig. 4).

**3.1.4.2** *Sample stream*

The fluid stream in the sample line.

NOTES

1 Other streams may be branched off the sample stream ( for example, by pass streams) or be injected into it ( for example, dilution streams ).

2 The composition and the physical state of the fluid in the sample line shall be allowed to change only in a predictable way.

3 The properties of the conditioned sample stream at the inlet of an analyser have to meet the requirements of the analyser.

3.1.4.3 *By pass stream*

A fluid stream which is branched off the sample stream.

NOTES

1 It is frequently the purpose of bypass streams to improve the delay time of the sample handling system ( fast loop ).

2 The term 'bypass stream' is also used for process lines, so the sample stream may be extracted from a bypass stream of a process stream.

3.1.5 *Sample Conditioning*

The function of those parts of a sample handling system which make the physical and/or chemical properties of the sample stream suitable for the

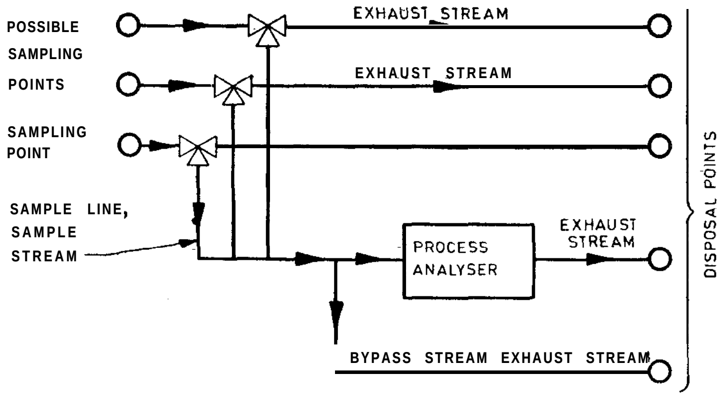

FIG. 1 SCHEMATIC EXAMPLE FOR THE USE OF TERMS DESCRIBING THE FUNCTIONS OF SAMPLE TRANSPORT AND EXHAUST STREAM DISPOSAL

**process analyser without changing the composition unless this is done in a predictable way.**

NOTES

1 In sample conditioning the sample stream is treated in a predictable way whereby obstructive and interfering components are removed or converted as far as necessary.

2 The requirements the sample conditioning has to meet depends on the physical and chemical properties of the source fluid as well as on the admissible inlet conditions of the process analyser.

**3.1.5.1** *Conditioned sample&id*

**The sample fluid suitably conditioned for the analysis.**

**3.1.6** *Exhaust Streum Disposal*

**The function of those parts of a sample handling system which connect the outlet of the process analyser or another point in the sample handling system with a disposal point.**

NOTES

1 This function should so be realised that the requirements for the analyser outlet or for other points in the sample handling system are met as well as those for the disposal point.

2 The instrumentation for exhaust stream disposal depends very much on the physical state (liquid or gaseous) of the exhaust stream. One sample handling system may give rise to exhaust streams of different states.

*3.1.6.1 Disposal point*

**The point to which exhaust streams are transferred.**

NOTE-A disposal point can be in the open air, the inlet to a process line or volume, or the inlet to a disposal system external to the sample handling system.

*-3.1.6.2 Exhaust stream*

**A fluid stream from the process analyser outlet or from an other point in the sample handling system to a disposal point.**

**3.1.7** *Supply of Utilities*

**The function of those parts of a sample handling system which supply the process analyser or components of the sample handling system with utilities ( for example, pressurised air, water for cooling, steam for heating, test fluids for calibration, electric power ).**

**3.1.7.1** *Test fluid ( Calibration fluid )*

**A fluid with known quantities or properties to be measured.**

**3.1.8** *Sample Stream Switching*

**The function of those parts of a sample handling system which sequentially connect the process analyser automatically or manually to different sampling points.**

NOTE — The electronics or pneumatics which control valves used for sample stream switching and/or adequately process the output signal of the analyser are considered part of the sample stream switching if they are functional part of the sample handling system.

**3.1.9** *Performance Monitoring and Control*

**The function of those parts of a sample handling system by which the performance of the system or of the process analyser can be checked, maintained or re-established either automatically or manually.**

NOTES

1 Sample handling system components as well as analysers may include elements which serve the performance monitoring and control.

2 Euipment which serves the maintainability of the sample handling system or of the analyser ( for example, valves for draining off condensate or facilities for re-calibration) are considered part of the performance monitoring and control (see Annex A, Fig. 4 for an example ).

**3 Equipment in which signals from measuring instruments or sensors or any sample handling system components are processed for maintenance or reliability reasons and which are an integral part of the sample handling system are considered part of the performance monitoring.**

3.1.10 *Sample Handling System Component*

Any device which is used for realisation of the functions of a sample handling system.

3.1.10.1 *Filter*

A device which removes soild particles ( and/or liquid droplets if used forgaseous streams ) from a fluid stream.

**NOTE- Filtering can be done mechanically or by coalescing or with electric precipitators.**

**3.1.10.2** *Separator*

A device in which one liquid phase is separated from another.

**3.1.10.3** *Absorber*

A device which separates components from a fluid stream by absorption or chemical reactions.

3.1.10.4 *Converter*

A device in which the chemical constitution of one or more components in a stream is changed.

**NOTE -A converter may convert an obstructive or interfering component into an irrelevant one or a component to be measured into a measurable one.**

**3.1.10.5** *Scrubber*

A device in which a gaseous stream is passed through a liquid for washing out solids or droplets or gaseous components.

3.1.10.6 Cooler ( *Heater* )

A device in which one or more sample streams are cooled ( heated ).

**3.1.10.7** *Pump*

A device for actively transferring fluids.

**3.1.10.8** *Phuse exchanger*

A device in which a component or group of components to be measured and present in a fluid of one physical state is at least partly transferred into a fluid of a different physical state.

**NOTE-A device for transferring a component or group of components from a liquid into a gas stream is frequently called a stripper.**

**3.1.10.9** *Vapor iser*

A device for totally converting a liquid into a gas.

3.1.10.10 *Sampling probe*

A device to be inserted into a process stream or volume for the purpose of extraction of a sample stream.

**NOTE -A sampling probe may comprise parts for sample conditioning ( for example, a filter ).**

3.1.11 *Performance*

The degree to which the intended functions of a sample handling system or of a sample handling system component are accomplished.

3.1.11.1 *Performance characteristic*

One of the quantities assigned to a sample handling system or a sample handling system component in order to define by values, tolerances, ranges, etc, the performance of the system or component.

3.1.12 *Influence Quantity*

Any quantity, generally extended to a sample handling system or sample handling system components which may effect the performance of the system or component. ( Examples: ambient temperature, ambient pressure, corrosive atmosphere ).

3.1.13 *Specified Range, Specified Value*

The range (value ) of a quantity to be measured, observed, supplied or set where a sample handling system or system component works within the limits of performance characteristics as stated by the manufacturer.

3.2 Terms Related to Conditions of Operations, Transportation and Storage

**NOTE — The specified ranges of use. the reference conditions and the limit con&ions of operation, storage and transport for all influence quantities shall be stated and selected only from one of the groups listed in Annex B.**

Any exceptions to the values given there shall be explicitly and clearly stated by the manufacturer with an indication that they are exceptions.

3.2.1 *Specified Operating Conditions*

The whole of:

— effective ranges and values of performance characteristics;

— specified ranges of use;

- specified ranges and values for source fluid conditions at the sampling point(s), ( see 5.1.1 );
- specified ranges and values for exhaust stream conditions at the disposal point(s) ( see 5.1.2 ); and
- specified ranges and values for utilities ( see 5.1.3) within which the sample handling system is specified.

3.2.1.1 *Specified range of use ( refer to Annex B )*

The range of values for an influence quantity within which the sample handling system or system component works within the limits of performance characteristics as stated by the manufacturer.

3.2.2 *Reference Conditions ( refer to Annex B)*

A set of values with tolerances or restricted ranges of influence quantities specified for making comparison tests.

3.2.3 *Limit Conditions of Operation (refer to Annex B)*

The whole of the ranges of values for influence quantities and performance characteristics ( beyond the specified ranges of use or effective ranges respectively ) within which an apparatus can function without resulting in damage or degradation of performance when it is afterwards operated under rated operating conditions.

3.2.4 *Limit Conditions of Storage and Transport ( refer to Annex B )*

All the conditions of temperature, humidity, air pressure, vibration, shock, etc, within which an apparatus may be stored or transported in an inoperative condition, without resulting in damage or degradation of performance when it is afterwards operated under specified operating conditions.

### 3.3 Terms Related to the Specification of the Performance of Sample Handling Systems and Sample Handling System Components

**3.3.0** *Introduction*

Compliance tests shall be performed with the sample handling system or the sample handling system component ready for use, after start-up time ( if necessary) and after performing adjustments according to the manufacturer's instructions.

**3.3.1** *Time Constants (see* Fig. 2 )

For test procedures ( see 5.5.1 ).

**3.3.1.1** *Delay time* ( $T_{10}$ )

The time interval from the instant a step change occurs in the concentration or property to be measured at the inlet, to the instant when the change in the outlet passes and remains beyond 10 percent of its steady-state difference, with the sample flow kept at its specified value.

NOTE — In sample handling systems the delay time frequently depends mainly on the time needed to transport the sample from the sampling point to the analyser inlet. This sample transport time can be determined with an analyser with small time constants together with suitable test fluids.

**3.3.1.2** *Rise (fall ) time* $T_r, T_f$

The time interval within which the concentration or property to be measured passes from 10 percent to ( and remains beyond ) 90 percent of its steady-state difference at the outlet after a step increase ( decrease ) in the concentration or property to be measured at the inlet, with the sample flow kept at its specified value.

3.3.1.3 90 *Percent time* ( $T_{90}$ )

The sum of the delay time and the rise or fall time, whichever is larger.

**3.3.1.4** Cycle *time*

For sample handling systems equipped with devices for automatic sample stream switching the cycle time is the time between two consecutive starts of the measurement period on the sample stream from the same sampling point.

NOTES

1 The cycle time is not necessarily identical for all sampling points.

2 If the time between two consecutive starts on any sample is less than 90 percent time of that part of the system between switching valve and process analyser special precautions are necessary for the interpretation of the output signal of the analyser.

For sample handling systems with discontinuously working sample extraction, sample transport or sample conditioning the cycle time between two consecutive starts of these operations.

3.3.1.5 *Time constants of sample handling system with automatic sample stream switching ( see 4.6.2 )*

For sample handling systems with automatic sample stream switching the time constants for measurements on one sample stream depend:

- on the time constants of the system between sampling point and switching valve, and
- on the time constants of the system between switching valve and process analyser.

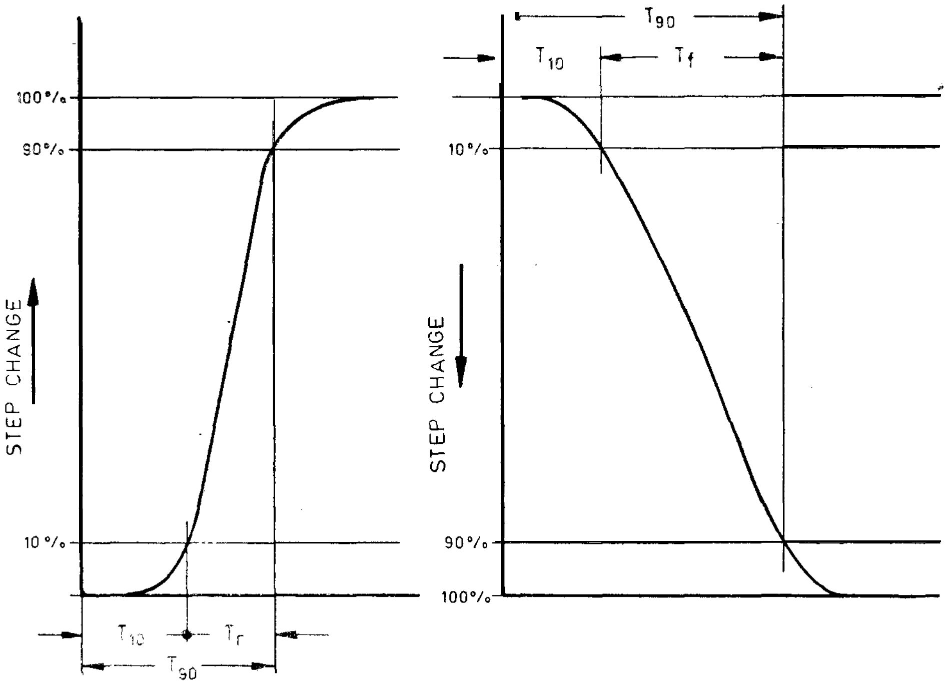

FIG. 2 TIME CONSTANTS AND RELATION BETWEEN $T_{10}$, $T_r$ ( $T_f$ ) AND $T_{90}$

Additionally they depend on the time-lag between the occurence of a concentration change at the sampling point and the start of the measurement period on the sample stream from that sampling point.

3.3.1.6 *Start-up time*

The time interval between switching on the power and other utilities, and the beginning of the sample handling system or system component working within the stated limits of performance characteristics.

3.3.2 *Leak Rate ( see 4.6.3 )*

The amount of unwanted fluid which enters ( for example, ambient air ) or leaves the sample handling system or system component per time unit with the system or component with in its specified range of operating pressure.

3.3.3 *Maintenance Requirements ( see 4.6.4 )*

The work which foreseeably has to be done to maintain the specified operating conditions of a sample handling system or system component. This will also include the re-calibration procedure.

3.3.4 *Status Signal*

Externally available binary signal which describes the status of a sample handling system component or of a sample handling system. This may include the status of the process analyser.

3.3.5 Special *Performance Characteristics*

NOTE — In sample conditioning the composition of the sample fluid may change, and the changes may affect the measurement. Their effect may be corrected by calculation or by compensation by appropriate calibration procedures, but errors specific for sample handling systems can remain.

Exclusively absolute errors are dealt with in the following:

3.3.5.1 *Volume effect ( enrichment effect )*

The effect on the concentration to be measured which results from removing components form the sample stream so that the concentration of the components to be measured is increased in the conditioned sample fluid.

NOTES

1 A typical example for increasing the concentration of the component to be measured is the removal of vapours for dry analysis.

2 The volume effect depends on the concentration of the components to be removed in the source fluid and in the conditioned sample fluid ( if the removal is not complete ). If these concentrations are known the volume effect can be calculated using the formula:

$$C_m = \left(\frac{1 - C\gamma}{1 - C'\gamma}\right) C'_m \qquad (1)$$

with $C_m$: concentration of the component to be measured in the source fluid,

$C'_m$: concentration to be measured in the conditioned sample fluid ( measured by the process analyser ),

$C\gamma$: concentration of the components to be removed in the source fluid, and

$C'\gamma$: concentration of the components to be removed in the conditioned sample fluid.

whereby the concentrations are given as volume fractions.

If necessary the correction for the volume effect can be based on estimates for the mean concentrations of $C\gamma$ and $C'\gamma$.

**3.3.5.2** *Volume error ( Enrichment error )*

The difference between the concentration to be measured at the sampling point and the concentration measured by the process analyser in the conditioned sample fluid [ possibly corrected by using formula (1) ] which results from removing components.

NOTE — If the concentration to be measured in the conditioned sample fluid is corrected by means of mean concentrations of $C\gamma$ and $C'\gamma$ the remaining volume error depends on their variation.

**3.3.5.3** *Dilution effect*

The effect on the concentration or property to be measured which results from injecting a dilution stream consisting of insert components into the sample stream. The dilution effect for concentrations can be calculated using the formula:

$$C_m = \left( 1 + \frac{Q_i}{Q_s} \right) C'_m \qquad (2)$$

with $C_m$: concentration to be measured before injection,

$C'_m$: concentration to be measured after injection,

$Q_s$: sample stream flow before injection, and

$Q_i$: flow of the injected dilution stream.

whereby the concentrations are given as volume fractions.

NOTE — The dilution effect can be compensated by calibrating the sample handling system and the process analyser with test fluids which are introduced upstream the injection instead of the sample stream and with the same flow.

**3.3.5.4** *Dilution error*

The difference between the concentration or property to be measured at the sampling point and the corrected [ by calculation using formula (2) or compensation ] concentration or property to be measured by the process analyser in the conditioned sample fluid, which results from flow variations in the sample or dilution flow.

NOTE — If the specified ranges of flow of the sample and dilution stream are known the error by dilution can be calculated using formula (2).

**3.3.5.5** *Composition error*

The difference between the concentration to be measured at the sampling point and in the conditioned sample fluid which arises from absorption, or dissolution, or permeation or reactions of the components to be measured within the sample streams.

NOTE — The composition error should be determined with the sample handling system and the process analyser working in their specified ranges of use. The analyser is calibrated, and then at the sampling point a test fluid is introduced that is similar to the source fluid but in which the concentration of the component to be measured is in a typical range and known. The composition error is the difference between the concentration known and that found by the process analyser.

**3.3.5.6** *Converter efficiency* ( *see* **4.6.5** )

The converter efficiency is characterised by the conversion factor in the equation:

$$C_m^* = \alpha . K . C_m \qquad (3)$$

with $C_m$: concentration of the component to be converted at the inlet of the converter;

$C_m^*$: concentration of the component produced by conversion at the converter outlet. If this component is not present at the inlet of the converter;

$\alpha$: conversion factor ( $\alpha = 1$, if conversion is complete ); and

$K$: the stochiometric ratio resulting from the conversion reaction.

whereby the concentrations are given as volume fractions.

NOTE — The Effect of the conversion efficiency on the measurements of the process analyser can be compensated by calibrating the sample handling system and the process analyser with test fluids containing the component to be converted, which are introduced upstream the converter instead of the sample stream.

**3.3.5.7** *Converter capacity* ( *see* **4.6.5** )

The amount of components to be converted which a converter is able to convert.

Usual dimension: concentration × time.

**3.3.5.8** *Conversion error*

The difference between the corrected [ by calculation using formula (3) or compensation ] concentration of the produced component at the converter outlet and the concentration of the component to be converted at the converter inlet, if the component to be produced by conversion is not present at the converter inlet.

3.3.5.9 *Phase exchanger efficiency ( see 4.6.5 )*

The phase exchanger efficiency is characterised by the transition factor in the equation:

$$C'_m = \beta \times C_m \qquad (4)$$

with $C'_m$: the concentration of the component to be measured in the fluid into which this component is transferred,

$C_m$: the concentration to be measured in the fluid from which this component is to be transferred, and

$\beta$: transition factor.

whereby the concentrations are given as volume fractions.

**NOTES**

**1 The transition factor $\beta$ depends on the solubility of the component to be transferred in the primary fluid, on the temperature; on the flow rates, and on the construction of the flow exchanger.**

**2 The effect of the phase exchanger efficiency on the measurement results of the process analyser can be compensated by calibrating the sample handling system process analyser with test fluids which are introduced upstream the phase exchanger.**

3.3.5.10 *Phase exchanger error*

The difference between the corrected [by calculation using formula (4) or compensation ] concentration in the sample stream outlet and concentration of the component to be measured in the fluid at the sample stream inlet of the phase exchanger.

## 4 PROCEDURE FOR STATEMENTS

**4.1** A list of statements follows which may be important for the manufacturer of sample handling systems or for their user. Due to the structure of sample handling systems (see Annex A, Fig. 3 ) the manufacturer of sample handling systems needs statements to be provided by the user (4.2 ), by the manufacturer of the process analyser ( 4.3 ), and by the manufacturer of sample handling system components ( 4.4). The user will need statements specifying the performance of the sample handling system which are to be provided by the manufacturer of the system ( 4.5 ).

The choice of statements necessary depends on the special case. So the following may be used as a check list from which the necessary statements can be selected. The statements usually of primary interest and necessary almost in each case are marked by an asterisk (*).

To be more practical, minimum, normal and maximum values may be stated instead of ranges. By this way also abnormal situations shall be taken into account.

### 4.2 Statements Concerning the Requirements for a Sample Handling System ( User )

**4.2.1** *Statements Concerning the Source Fluid Conditions at the Sampling Point ( User )*

The following statements should be provided by the user as far as possible and for each sampling point:

* ranges of temperature.

* ranges of pressure.

* physical state(s).

* ranges of concentration of all components.

— specification of the process line at the sampling point.

— concentration and size data of particulates and/or droplets.

— density and viscosity of a liquid source fluid and if needed of a gaseous source at one or more temperatures.

— *p*H values of a liquid source fluid.

— ranges of velocity and flow and direction of the source fluid stream.

— dew point, double point, flash point and/or melting point.

— saturation temperature for solutes present in high concentration.

— critical properties of the source fluid such as corrosiveness, possible polymerisation reactions, other chemical reactions leading to a change of composition, etc.

4.2.2 *Statements Concerning the Conditions at the Disposal Points ( User and Manufacturer of Sample Handling System )*

The following statements should be agreed upon between the user and the manufacturer for each disposal point.

* range of pressure ( return pressure).

— range of temperature.

— admissible maximum concentration of hazardous components.

— maximum flow of exhaust stream.

**4.2.3** *Statements Concerning the Location ( User )*

The following statements should be provided by the user in order to specify under what environmental conditions the sample handling system has to work. If necessary special statements should be given for different areas in which parts of the sample handling system will be located.

* distance between analyser and disposal points.
* range of ambient temperature.
* available utilities ( specification of power supplies; pressure, temperature and quality of auxiliary fluids ).
* distance between sampling point and analyser.

— range of ambient pressure.

— height difference between sampling point and analyser ( for liquid sample streams ).

— area classification.

— corrosiveness of the atmosphere.

### 4.3 Statements Concerning the Requirements for a Sample Handling System ( Manufacturer of Process Analyser )

The following statements should be provided by the manufacturer of the process analyser in order to specify the requirements a sample handling system has to meet for the analyser.

4.3.1 *Process Analyser Inlet for the Sample Stream*

* admissible dew point.
* range of temperature of the sample stream.
* range of flow of the sample stream.
* interference error of interfering components present in the source fluid.
* admissible maximum concentration of obstructive components present in the source fluid.

— range of pressure.

— admissible range of density.

— admissible range of viscosity.

**4.3.2** *Process Analyser Outlet of Exhaust Stream*

* range of pressure.
* range of flow.
* range of temperature.

4.3.3 *Process Analyser Inlet for Utilities*

* range of pressure of auxiliary fluids.
* range of flow of auxiliary fluids.
* requirements concerning the quality of auxiliary fluids.

— range of temperature of auxiliary fluids.

* specification of power supply and consumption of electric energy.

### 4.4 Statements Concerning Sample Handling System Components ( Manufacturer of Sample Handling System Components )

The following statements should be provided by the manufacturer of sample handling system components in order to specify the properties of the components so that their applicability can be judged. These informations are necessary for the manufacturer of sample handling systems whereas they are not necessary for the user of the complete system. They shall be made available to the user on request.

* a list of all materials which come into contact with the sample fluid.
* effective internal volume.
* range of pressure of the sample fluid.
* range oftemperature of the sample fluid.
* range of sample fluid flow.
* pressure drop at specified flow rate of sample fluid.
* performance characteristics ( see 4.3 and 4.5 for possibly applicable performance characteristics ).
* requirements for environment conditions.

— limit conditions of operation.

— limit conditions of storage and transport.

— requirements for utilities.

— specification of status signals together with their meaning and possible causes.

— instructions for installation ( for example, of sampling probes ).

### 4.5 Statements Concerning Sample Handling Systems (Manufacturer of Sample Handling Systems )

The following statements should be provided by the manufacturer of sample handling systems in order to specify the properties of the sample handling system:

* ranges of pressure of auxiliary fluids.
* ranges of temperature of auxiliary fluids,
* quality requirements for auxiliary fluids.
* consumption of auxiliary fluids.

- * ranges of power supply.
- * consumption of electric energy.
- * environment conditions for the sample handling system or parts of it.
- * performance characteristic (see 3.3 and 4.6 for possibly applicable performance charact eristics ).
- * output signals ( for example in sample handling systems with automatic sample stream switching ).

- — limit conditions of operation.
- — limit conditions of storage and transport.
- — specification of status signals together with their meaning and possible causes.
- — instruction for installation.
- — instruction for re-calibration procedures.
- — instruction for start-upprocedure.

### 4.6 **Special Statements**

In the following some statements of special performance characteristics are commented.

4.6.1 *Verification of Time Constants of a Measuring System for Process Analysis ( see 4.3.1)*

To determine the time constants of a complete measuring system for process analysis Comprising a sample handling system and a process analyser the following procedure can be performed.

While the process analyser output is recorded the sampling point is flushed with a test fluid until a constant reading to the analyser is obtained. Then the sampling point is flushed with a test fluid of a composition that will give rise to an analyser signal change between 65 percent and 95 percent of full scale. The values for the time constants are determined from the time elapsed since the start of inserting the latter test fluid.

If either appropriate test fluids are not available or introducing test fluids at the sampling point is not possible, the following procedure can be performed for a system which is attached to a source fluid of a nearly constant composition which gives rise to an analyser signal of between 50 percent and 95 percent of full scale.

The sample handling system and the analyser are completely backflushed with a fluid that is similar to the source fluid but which will not give rise to an analyser signal greater than 10 percent of full scale. Then backflushing is stopped and with the analyser and sample handling system working at their specified operating conditions the analyser signal is recorded.

The delay time and the rise time are determined by evaluating the recorded analyser signal. Alternative test methods may be agreed upon by the manufacturer and the user.

4.6.2 *Time Constants of Sample Handling Systems with Automatic Sample Stream Switching ( see 3.3.1.5 )*

The 90 percent time of measuring systems with automatic sample stream switching should be stated for the best and worst cases.

4.6.3 *Leak Rate ( see 4.3.2 )*

The leak rate of a system or component can often be determined by measuring the pressure loss or increase with closed inlets and outlets. For many cases that system is sufficiently sealed in which an overpressure of about 100 mbar air after temperature equalization decreases within 10 minutes by less or equal 1 percent of the pressure difference. Alternative test methods should be agreed upon between the manufacturer and the user.

4.6.4 *Maintenance Requirements ( see 3.3.3 )*

Maintenance requirements normally depend in a large extent on the conditions under which a sample handling system or system component has to work. Therefore they should be stated for conditions which the manufacturer and the user agree upon.

The manufacturer should supply the user with information necessary for him to estimate the maintenance costs. The information should include, but is not limited to:

- — a description of the work which foreseeably has to be carried out to maintain the operating conditions of the sample handling system or system component,
- — the frequency with which this work or parts of it have to be repeated,
- — the material ( spare parts, reagents, etc ). which are consumed for this work, and
- — list of recommended spare parts.

The information should be sufficiently complete to allow the user to estimate the maintenance expenditure.

4.6.5 *Efficiency and Capacity of Converters (see 3.3.5.6 and 3.3.5.7 )*

The ranges of converter efficiency and of converter capacity should be stated by the manufacturer for the specified ranges of use ( for example, flow: concentration of the component to be converted, etc ) and if necessary together with the maximum concentration of the component to be converted.

4.6.6 ***Phase Exchanger Efficiency ( see 3.3.5.9 )***

If the phase exchanger efficiency is not compensated in the calibration procedure it should be stated for each component to be transferred, for the fluids used and for the specified range of use (especially flows and temperature ).

# ANNEX A

## ( Clauses 3.1, 3.1.2, 3.1.4.1 and 4.1 )

## PURPOSE, FUNCTIONS AND PROPERTIES OF SAMPLE HANDLING SYSTEMS

A-1 A complete measuring device for process analysis consists of at least one process analyser and a peripheral system called sample handling system in which the process analyser is embedded.

A-2 In Fig. 3 the requirements of the process analyser for the properties of the sample fluid at its inlet are characterised by a set of quantities and ranges $(Z_i)$. The set $(Z_o)$ characterises its requirements for the outlet and the set $(Z_a)$ those at the inlet for auxiliary fluids.

A-2.1 Possible basic functions:

- sample extractions,
- sample transport,
- sample conditioning,
- sample stream switching and signal processing,
- supply of utilities,
- exhaust stream disposal.

A-2.2 Additional function:

- performance monitoring and control

A-2.3 Properties:

- response time,
- errors,
- reliability, and
- investment and maintenance expense.

A-2.4 The process analyser with its specified requirements has to be connected to the sampling points and the environment by means of a sample handling system. The properties of the source fluid at the sampling points are qualified by the set $(Z_S)$, auxiliary fluids and power supplies are provided for the system with the properties $(Z_A)$, and the possible conditions at the disposal point are described by the set $(Z_D)$.

A-2.5 The tasks of a sample handling system can be the following:

- to change the properties $(Z_S)$ of the sample stream at the sample point so that

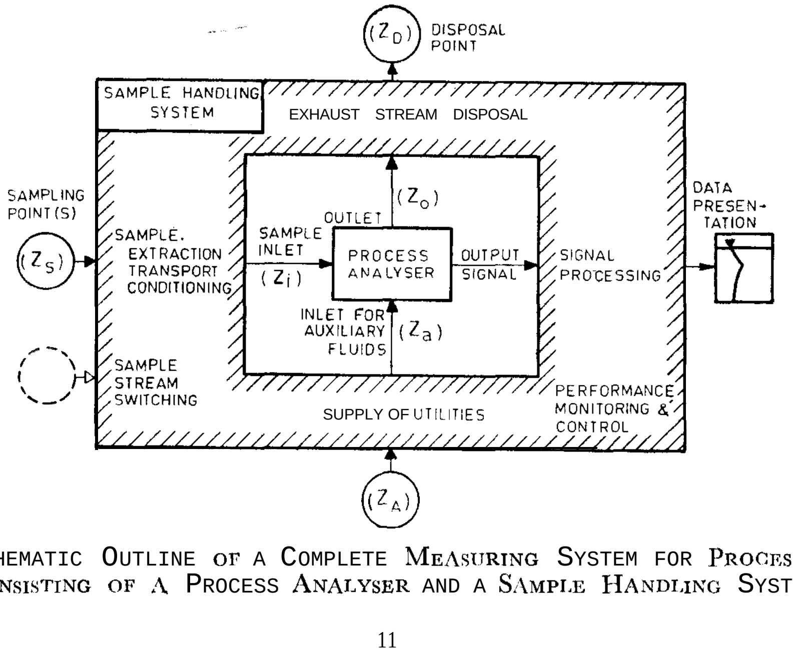

FIG. 3 SCHEMATIC OUTLINE OF A COMPLETE MEASURING SYSTEM FOR PROCESS ANALYSIS CONSISTING OF A PROCESS ANALYSER AND A SAMPLE HANDLING SYSTEM

the requirements ($\mathfrak{Z}_i$) of the processor analyser for its inlet are met,

- to change the properties ($\mathfrak{Z}_A$) of the utilities provided so that the requirements of the process analyser ($\mathfrak{Z}_a$) and if necessary of sample handling system components are met,
- to connect the process analyser outlet with the point of disposal so that the respective requirements ($\mathfrak{Z}_o$) and ($\mathfrak{Z}_D$) are met, and
- to process the output signal of the analyser so that the wanted information can be delivered; this is especially then needed when the process analyser is sequentially connected with different sampling points.

A-2.5.1 So a sample handling system may perform the following basic functions:

- sample extraction,
- sample transport,
- sample conditioning,
- exhaust stream disposal,
- supply of utilities, and
- sample stream switching and signal processing.

A-3 For obtaining a sufficient reliability and for keeping the maintenance expense on an economically justified level it is normally necessary to realise the additional function:

- performance monitoring and control.

The possibilities of instrumentation for this function are manifold. They reach from equipping the system with simple measuring instruments (for example, flowmeter, manometer ) and values for rinsing with test fluids up to the automation of the performance monitoring and control by means of status sensors and complex electronics. These may also be able to perform routine maintenance work ( for example, calibrations ) automatically and to give externally available failure reports for improving the reliability.

A-3.1 Not all of the basic functionshave to be realised in all cases 'sample stream switching' is comparatively seldom necessary, and for in line or ***in-situ*** analysers the functions 'sample extraction' 'sample transport', and 'sample conditioning' have not to be performed, whereas the function 'supply of utilities' may nevertheless be needed. For some portable and battery driven analyser (for example; for work place hygienic measurements ) a sample handling system is not at all necessary.

A-4 A simple example for a complete measuring system is shown in Fig. 4. It is assumed that the pressure at the sampling point is high enough for transferring the sample stream through the sample handling system and the analyser to the disposal point in the open air. The function, 'sample stream switching' and 'supply of utilities' are not realised in this example.

A-5 The following table contains the sample handling system components of the example together with the functions of the system they help to realise:

| Functions / Components | Sample | | | Exhaust Stream Disposal | Performance Monitoring and Control |
|---|---|---|---|---|---|
| | Extraction | Transport | Conditioning | | |
| **Sampling probe with in line-filter** | x | x | x | | |
| **Valve** | | x | | | x |
| **Heated sample line** | | x | | | |
| **Filter ( coalescer )** | | x | x | | |
| **Cooler** | | x | x | | |
| **Absorber** | | x | x | | |
| **Valve for calibration gases** | | | | | x |
| **Needle valve** | | x | x | | x |
| **Flowmeter** | | x | | | x |
| **Exhaust line** | | | | x | |

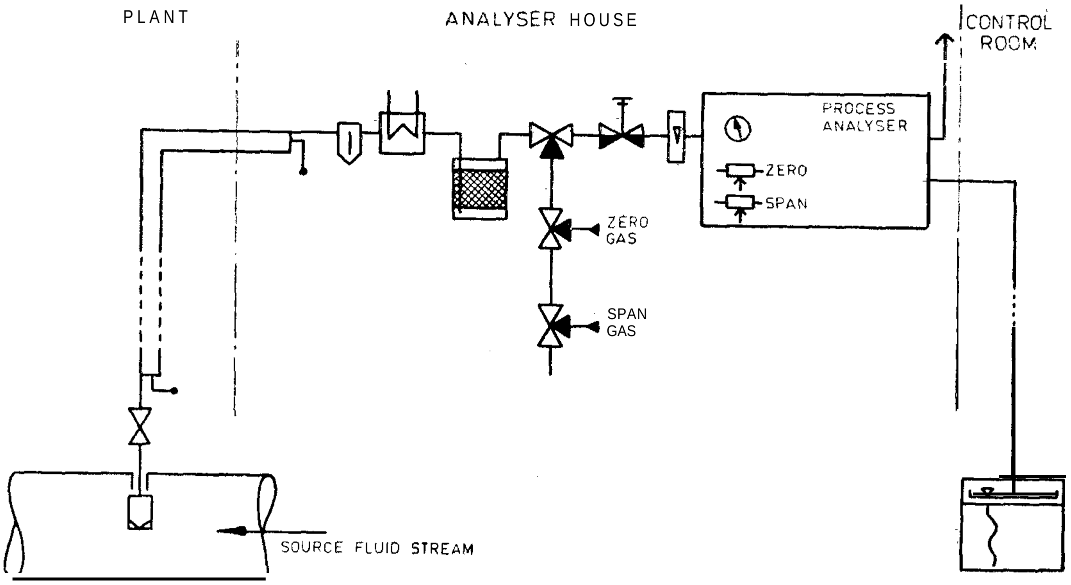

FIG. 4 SIMPLE EXAMPLE FOR A COMPLETE MEASURING SYSTEM FOR PROCESS ANALYSIS

The process analyser comprises components ( indicator, potentiometers for re-calibrations ) which also serve the function 'performance monitoring and control'.

A-6 It is the purpose of a complete measuring system to provide information about chemical or physical properties of the source fluid. The sample stream carries the information from the sampling point to the analyser which transforms it into a signal. Errors may not only arise within the process analyser but also in the sample handling system, if the properties of the sample stream are changed in an uncontrolled way so shat it looses an unknown part of information to be acquired. If the functions 'sample extraction', 'sample transport', and above all 'sample conditioning' are performed, errors are possible and have to be taken into account which are specific for sample handling systems (for example, composition error, volume error, dilution error, etc ).

A-6.1 For the properties of a complete measuring system important demands can arise with emphasis depending on the special cases. The most important properties are:

- time constants,
- errors,
- reliability ( operational availability ),
- investment expense, and
- maintenance expense.

A-6.2 Other important properties ( for example, safety characteristics) are not dealt with in this standard. The properties of a complete system depend on the process analyser as well as on the construction of the sample handling system.

A-7 A sample handling system has to be constructed so that the demands concerning its properties are met as far as possible. With many measuring systems for process analysis it is the sample handling system rather than the process analyser that is more frequently the source of poor performance or breakdown. The objectives of maintenance should be that the accuracy and availability are continuously and reliably achieved.

# ANNEX B

( *Clauses* 3.2, 3.2.1.1, 3.2.2, 3.2.3 *and* 3.2.4)

## OPERATING GROUPS AND LIMIT RANGES OF OPERATION, STORAGE AND TRANSPORT

**B-1** The operating ranges of influence quantities are divided into five operating groups, according to the severity of the environment, as shown in Table 1.

B-2 Out of the many possible influence quantities only a few are important in the environments in which most sample handling systems and process analysers are used. These

**quantities are referred to as primary influence quantities. Limit values or operating ranges for primary influence quantities according to operating groups are given or described in Table 2. The limit ranges for operation, storage and transport are given in Table 3.**

### Table 1 Operating Groups

( *Clause* B-1 )

| Operating Group | Operating Conditions |
|---|---|
| *A* | The environment existing in standards laboratories, under suitable conditions for calibrations, and for measurements to resolve disputes.<br>NOTE — The ranges for influence quantities may be chosen to be reference ranges or nominal ranges of use as given in other Indian Standards. |
| *B* | The environment existing indoors under conditions which are normally found in laboratories and light industries, and where equipment will be handled carefully. |
| *C* | The environment existing under conditions which are normally found in heavy industries. |
| *D* | An uncontrolled environment in which the equipment may be subjected to rough usage. |
| *E* | Special environmental requirements relating to usual fields of use.<br>NOTE-For this group the details will be subject of special agreement between the manufacturer and the user. |

### Table 2 Primary Influence Quantities According to Operating Groups

( Clause B-2 )

| Primary Influence Quantity | Limit Values of Ranges | | | | | |
|---|---|---|---|---|---|---|
| | Reference Value or Range | Operating Range | | | | |
| | All Operating Groups | Operating Group A, Standard Laboratories | Operating Group B, General Laboratories and Light Industry | Operating Group C, Heavy Industry | Operating Group D, Uncontrolled Environment | Operating Group E, Special Duty |
| 1 Ambient temperature ( Notes 1 & 2 ) | 20, 23, or 27°C ± 1°C | As stated in Indian Standard relevant to equipment ( for example, nominal range of use ) or as agreed to between the manufacturer and the user | + 5 to + 40°C | − 10 to + 55°C | − 25 to + 70°C | As agreed to between the manufacturer and the user |
| 2 Relative humidity | 40 to 60 percent | | 30 to 70 percent | 10 to 90 percent | 5 to 95 percent | |
| 3 a Supply voltage | Rated value ± 1 percent | | Rated value ± 5 percent | Rated value ± 10 percent | Rated value ± 15 percent | |
| 3 b Attitude | Any stated attitude ± 1°C in any direction | | Any stated attitude ± 5 percent in any direction | Any stated attitude ± 30 percent in any direction | Any attitude | |

NOTES

1 These temperatures are taken from IS 196 : 1966. The reference temperature relating to a particular equipment must be explicitly stated. If a reference range for temperature is stated, it shall include at least one of these temperatures.

2 The tolerance is as shown unless a smaller tolerance is stated in a relevant Indian Standard.

### Table 3 Limit Ranges for Operation, Storage and Transport

( *Clause* **B-Z** )

| **Operating Group** | **Limit Range of Operation, ( Note 1)** | **Limit Range of Storage and Transport ( Note 2 )** | |
|---|---|---|---|
| Group A | Equal to operating range, unless otherwise stated in the relevant Indian Standard | As agreed to between the manufacturer and the user, unless otherwise stated in the relevant Indian Standard. | |
| Group B, C, D | Equal to operating range | Primary influence quantities | ( Temperature – 40 to + 70°C ) Relative humidity 5 to 95 percent |
| | | Secondary influence quantities | ( As agreed to between the manufacturer and the user ) |
| Group E | As agreed to between the manufacturer and the user | As agreed to between the manufacturer and the user | |

NOTES

1 The limit range of operation applies to all stated influence quantities.

2 The limit range of storage and transport applies only to those stated influence quantities which affect the equipment when it is not operating. For instance, supply voltage is not applicable.

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